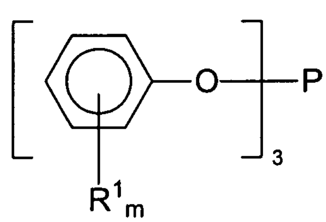
In the Claims

In light of the fact that brackets were used in many of the chemical formulas, the ability to show the examiner which parts of the claim were being amended was not possible. Therefore, please delete claims 1-41 and a new set of claims is being provided consecutively numbered 42-82. Support for these new claims can be found in the originally submitted claims.

42. A stabilized composition comprising:
    (a) a halogenated resin;
    (b) at least one phosphite ester selected from the group consisting of aryl phosphites, alkyl phosphites, aryl/alkyl phosphites, bisphenol-A phosphites, dialkylene glycol phosphites and polydialkylene glycol phosphites, pentaerythritol phosphites, *p*-cumyl phenol phosphites and blends thereof; and
    (c) approximately 50 to 800 ppm zinc per 100 parts resin.
43. The composition of claim 42 wherein
    (a) said zinc is from approximately 100 to 500 ppm.
44. The composition of claim 43 wherein
    (a) said zinc is from approximately 100 to 250 ppm.
45. The composition of claim 42 wherein said at least one phosphite ester is selected from the group consisting of
    aryl phosphites of formula (I)



(I)

wherein:

R^1 is independently selected from the group

consisting of H, C_{1-18} alkyl, C_{1-18} alkoxy, halogens; and

M is an integral value from 0 to 5 inclusive,

C1 Cont.

alkyl phosphites of formula (II)

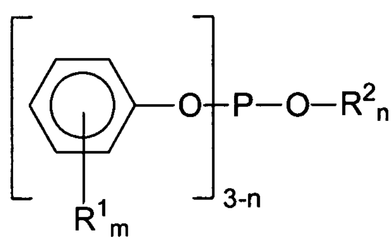
$$\left[R^2{-}O \right]_3 {-}P$$

(II)

wherein:

R^2 is selected from the group consisting of C_{1-18} alkyl,

alkyl/aryl phosphites of formula (III)



(III)

wherein:

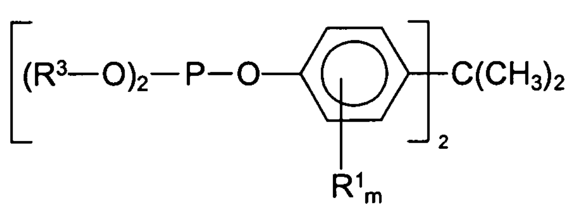
R^1 is as previously defined;

R^2 is as previously defined;

m is an integral value from 0 to 5 inclusive; and

n is an integral value from 1 to 2,

bisphenol-A phosphites of formula (IV)



(IV)

wherein

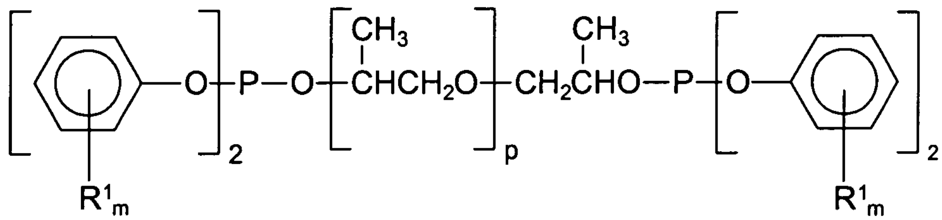
R^1 is as defined previously;

R^3 is C_{8-18} alkyl; and

M is an integral value from 0 to 5 inclusive,

C1 Cont.

polydialkylene glycol phosphites of formula (V)



(V)

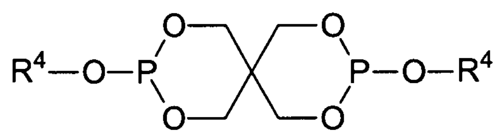
wherein:

R^1 is as defined previously;

m is an integral value from 0 to 5 inclusive; and

p is an integral value from 0 to 1 inclusive,

pentaerythritol phosphites of formula (VI)

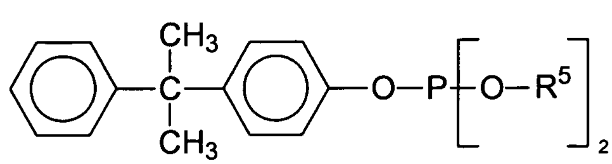


(VI)

wherein:

R^4 is selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy, and

p-cumyl phenol phosphites of formula (VII)



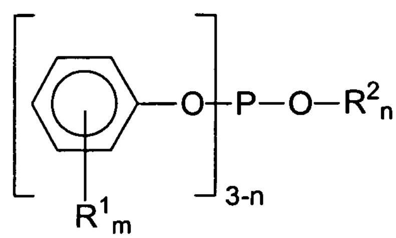
(VII)

wherein:

a' cont.

R^5 is independently selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy.

46. The composition of claim 45 wherein
    (a) a percentage weight loss of said composition as measured as a difference between a start and an end weight of said composition as measured after exposure to two hours at 110°C, is less than 1% by weight.
47. The composition of claim 46 wherein
    (a) a percentage weight loss is less than 0.5% by weight.
48. The composition of claim 47 wherein said at least one phosphite ester is selected from the group consisting of
    alkyl/aryl phosphites of formula (III)



(III)

wherein:

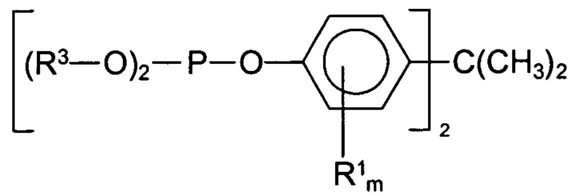
R^1 is independently selected from the group consisting of H, $C_{1\text{-}18}$ alkyl, $C_{1\text{-}18}$ alkoxy, halogens; and

R^2 is selected from the group consisting of $C_{1\text{-}16}$ alkyl,

m is an integral value from 0 to 5 inclusive; and

n is an integral value from 1 to 2,

bisphenol-A phosphites of formula (IV)



(IV)

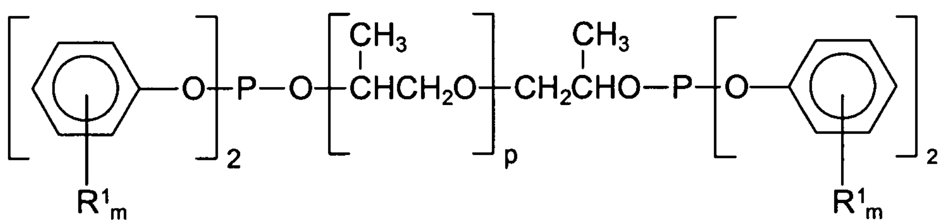
wherein

R^1 is as defined previously;

R^3 is $C_{8\text{-}18}$ alkyl; and

m is an integral value from 0 to 5 inclusive,

polydialkylene glycol phosphites of formula (V)



(V)

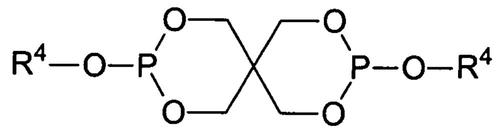
wherein:

R^1 is as defined previously;

m is an integral value from 0 to 5 inclusive; and

p is an integral value from 0 to 1 inclusive,

pentaerythritol phosphites of formula (VI)



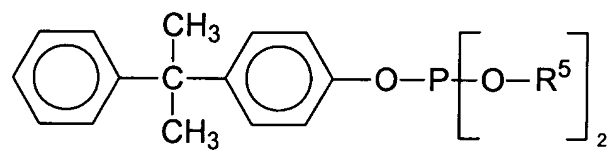
(VI)

a'
cnt.

wherein:

R^4 is selected from the group consisting of C_{8-16} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy, and

p-cumyl phenol phosphite is of formula (VII)



(VII)

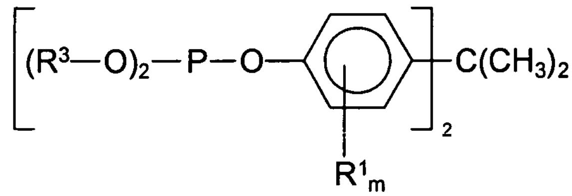
wherein:

R^5 is independently selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy.

49. The composition of claim 48 wherein said at least one phosphite ester is selected from the group consisting of

a1 cont.

bisphenol-A phosphites of formula (IV)



(IV)

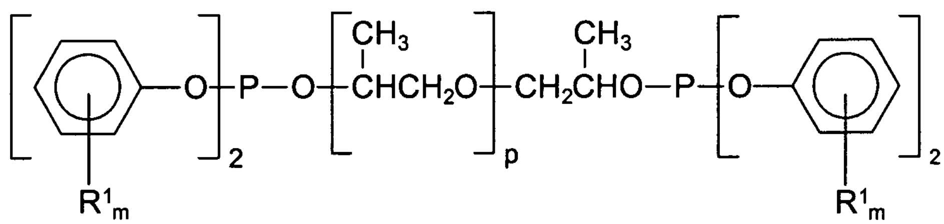
wherein

R^1 is independently selected from the group consisting of H, C_{1-18} alkyl, C_{1-18} alkoxy, halogens; and

R^3 is C_{8-18} alkyl; and

m is an integral value from 0 to 5 inclusive,

polydialkylene glycol phosphites of formula (V)



(V)

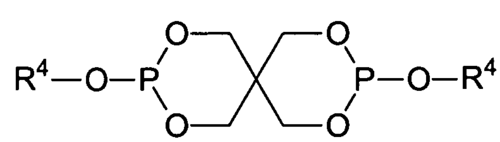
wherein:

R^1 is as defined previously;

m is an integral value from 0 to 5 inclusive; and

p is an integral value from 0 to 1 inclusive, and

pentaerythritol phosphites of formula (VI)



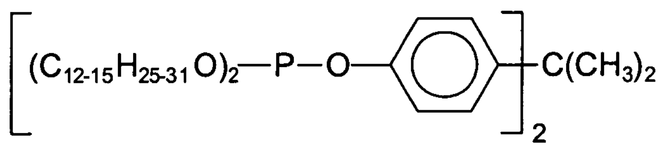
(VI)

wherein:

R^4 is selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy.

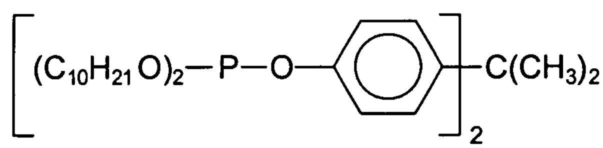
50. The composition of claim 49 wherein
   (a) said composition is essentially free of barium, cadmium and calcium.

51. The composition of claim 50 wherein
   (a) said phosphite ester is selected from the group consisting of
      C_{12-15} bisphenol-A phosphite of formula (VIII)



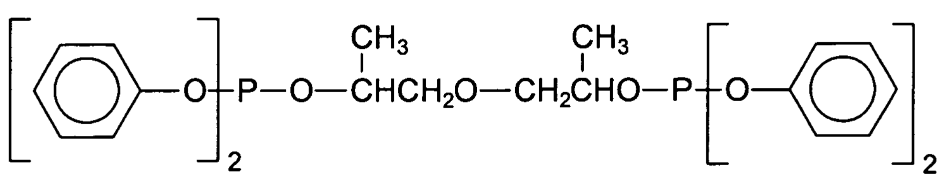
(VIII)

      C_{10} bisphenol-A phosphite of formula (IX)



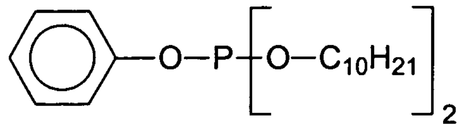
(IX)

      tetraphenyl dipropylene glycol diphosphite of formula (X)



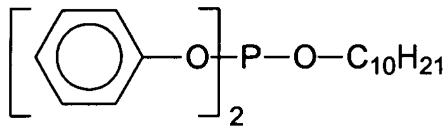
(X)

phenyl diisodecyl phosphite of formula (XI)



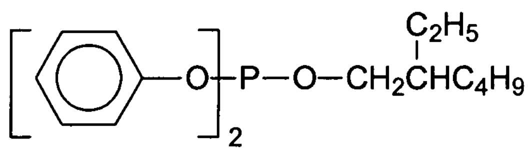
(XI)

diphenyl isodecyl phosphite of formula (XII)



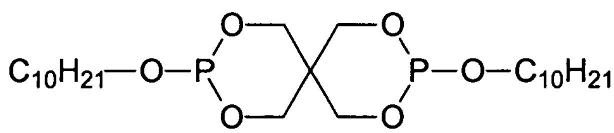
(XII)

diphenyl 2-ethylhexyl phosphite of formula (XIII)



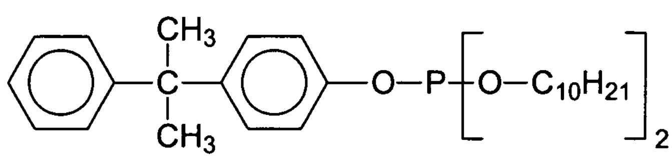
(XIII)

diisodecyl PE diphosphite of formula (XIV), and



(XIV)

mono *p*-cumyl phenol diisodecyl phosphite of formula (XV)



(XV).

52. A resin composition comprising:

(a) a halogenated resin;

(b) at least one phosphite ester selected from the group consisting of aryl phosphites, alkyl phosphites, aryl/alkyl phosphites, bisphenol-A phosphites,

dialkylene glycol phosphites and polydialkylene glycol phosphites, pentaerythritol phosphites, *p*-cumyl phenol phosphites and blends thereof;

(c) approximately 50 to 800 ppm zinc per 100 parts resin; and

(d) a molar ratio of P/Zn of about 80:1 to 4:1.

a1 cont.

53. The composition of claim 52 wherein

(a) said zinc is from approximately 100 to 500 ppm; and

(b) said molar ratio of P/Zn is about 75:1 to 6:1.

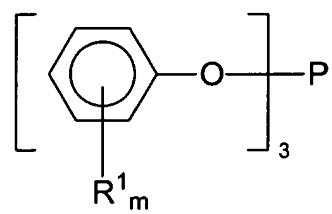
54. The composition of claim 53 wherein

(a) said zinc is from approximately 100 to 250 ppm; and

(b) said molar ratio of P/Zn is about 73:1 to 8:1.

55. The composition of claim 52 wherein said at least one phosphite ester is selected from the group consisting of

aryl phosphites of formula (I)



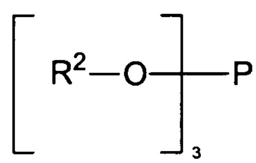
(I)

wherein:

R^1 is independently selected from the group consisting of H, C_{1-18} alkyl, C_{1-18} alkoxy, halogens; and

m is an integral value from 0 to 5 inclusive,

alkyl phosphites of formula (II)



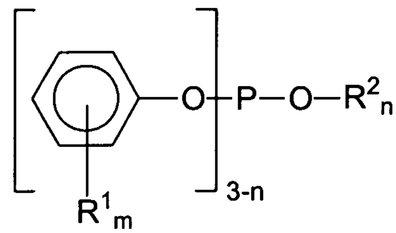
(II)

wherein:

R^2 is selected from the group consisting of C_{1-18} alkyl,

a1 cont.

alkyl/aryl phosphites of formula (III)



(III)

wherein:

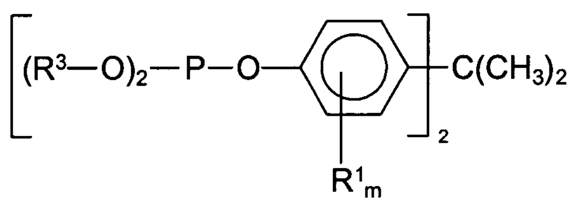
R^1 is as previously defined;

R^2 is as previously defined;

m is an integral value from 0 to 5 inclusive; and

n is an integral value from 1 to 2,

bisphenol-A phosphites of formula (IV)



(IV)

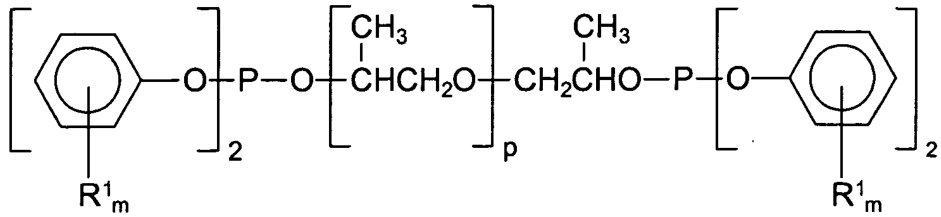
wherein

R^1 is as defined previously;

R^3 is C_{8-18} alkyl; and

m is an integral value from 0 to 5 inclusive,

polydialkylene glycol phosphites of formula (V)



(V)

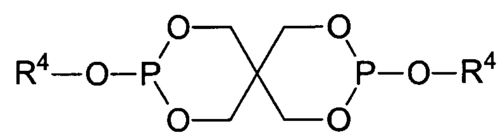
wherein:

R^1 is as defined previously;

m is an integral value from 0 to 5 inclusive; and

p is an integral value from 0 to 1 inclusive,

pentaerythritol phosphites of formula (VI)

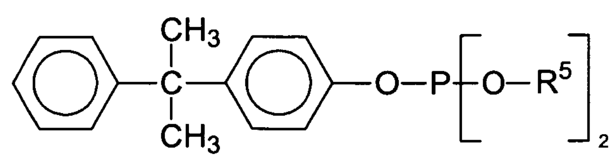


(VI)

wherein:

R^4 is selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy, and

p-cumyl phenol phosphites of formula (VII)



(VII)

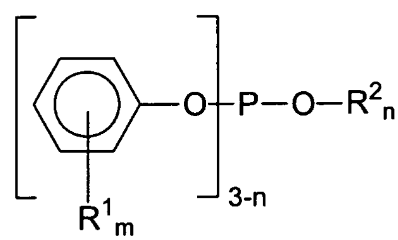
al
ut'

wherein:

R^5 is independently selected from the group consisting of $C_{8\text{-}18}$ alkyl; $C_{6\text{-}30}$ aryl, $C_{6\text{-}30}$ fused aryl rings, $C_{7\text{-}35}$ alklaryl, $C_{7\text{-}35}$ arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, $C_{1\text{-}4}$ alkyl, and $C_{1\text{-}4}$ alkoxy.

56. The composition of claim 55 wherein
   (a) a percentage weight loss of said composition as measured as a difference between a start and an end weight of said composition as measured after exposure to two hours at 110°C, is less than 1% by weight.
57. The composition of claim 56 wherein
   (a) a percentage weight loss is less than 0.5% by weight.
58. The composition of claim 57 wherein said at least one phosphite ester is selected from the group consisting of

alkyl/aryl phosphites of formula (III)



(III)

a1 cnt.

wherein:

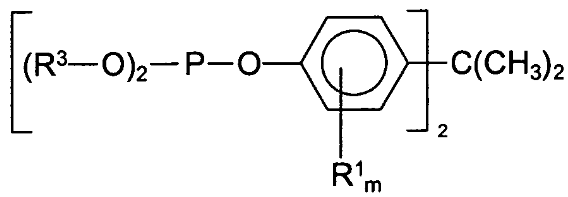
R^1 is independently selected from the group consisting of H, C_{1-18} alkyl, C_{1-18} alkoxy, halogens; and

R^2 is selected from the group consisting of C_{1-18} alkyl,

m is an integral value from 0 to 5 inclusive; and

n is an integral value from 1 to 2,

bisphenol-A phosphites of formula (IV)



(IV)

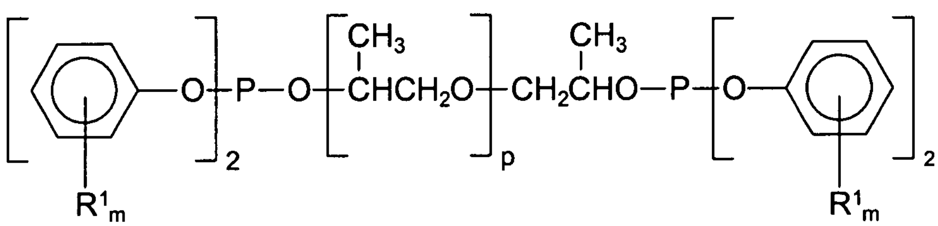
wherein

R^1 is as defined previously;

R^3 is C_{8-18} alkyl; and

m is an integral value from 0 to 5 inclusive,

polydialkylene glycol phosphites of formula (V)



(V)

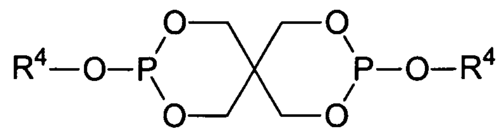
wherein:

R^1 is as defined previously;

m is an integral value from 0 to 5 inclusive; and

p is an integral value from 0 to 1 inclusive,

pentaerythritol phosphites of formula (VI)



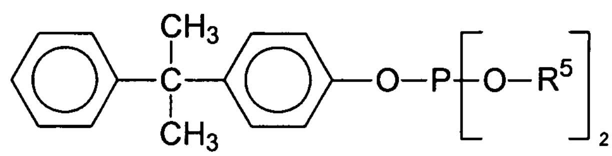
(VI)

ai
wf.

wherein:

R^4 is selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy, and

p-cumyl phenol phosphite is of formula (VII)



(VII)

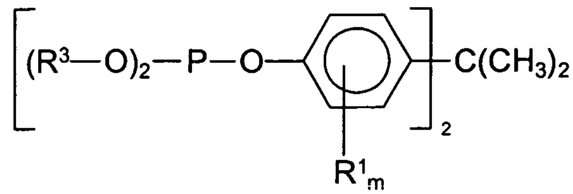
wherein:

R^5 is independently selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy.

59. The composition of claim 58 wherein said at least one phosphite ester is selected from the group consisting of

bisphenol-A phosphites of formula (IV)

al
unt.



(IV)

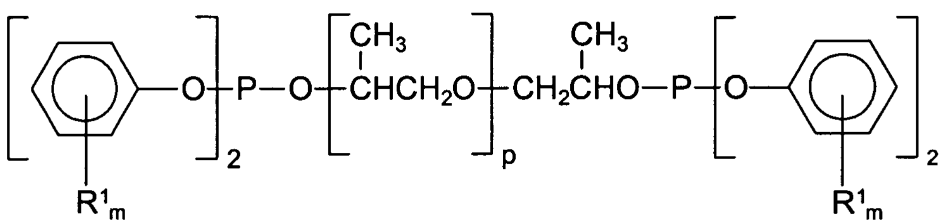
wherein

R^1 is independently selected from the group consisting of H, C_{1-18} alkyl, C_{1-18} alkoxy, halogens; and

R^3 is C_{8-18} alkyl; and

m is an integral value from 0 to 5 inclusive,

polydialkylene glycol phosphites of formula (V)



(V)

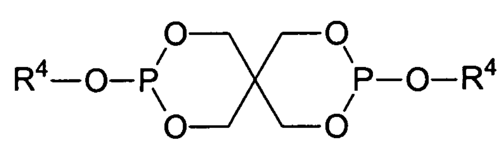
wherein:

R^1 is as defined previously;

m is an integral value from 0 to 5 inclusive; and

p is an integral value from 0 to 1 inclusive, and

pentaerythritol phosphites of formula (VI)



(VI)

a1 cont.

wherein:

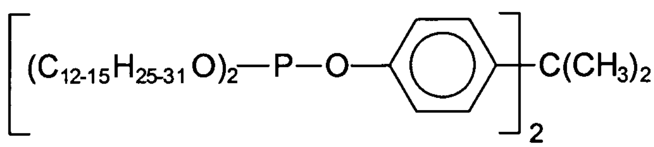
R^4 is selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy.

60. The composition of claim 59 wherein said composition is essentially free of barium, cadmium and calcium.

61. The composition of claim 60 wherein

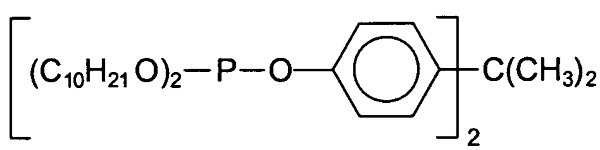
(a) said phosphite ester is selected from the group consisting of

C_{12-15} bisphenol-A phosphite of formula (VIII)



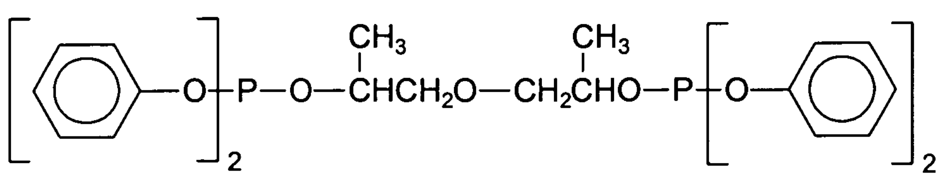
(VIII)

C_{10} bisphenol-A phosphite of formula (IX)



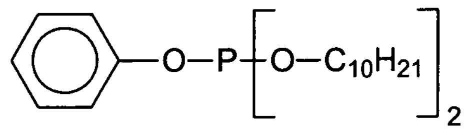
(IX)

Tetraphenyl dipropylene glycol diphosphite of formula (X)



(X)

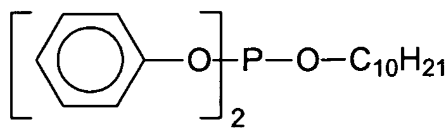
phenyl diisodecyl phosphite of formula (XI)



(XI)

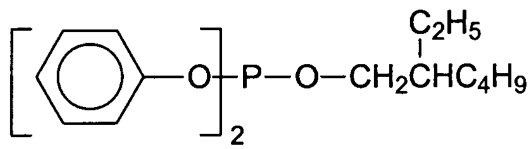
a1
wd.

diphenyl isodecyl phosphite of formula (XII)



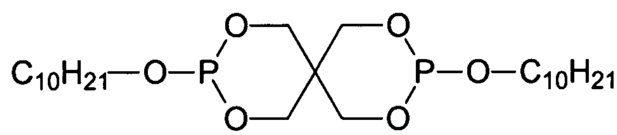
(XII)

diphenyl 2-ethylhexyl phosphite of formula (XIII)



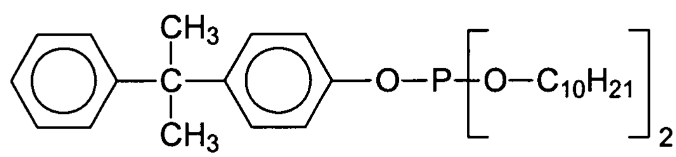
(XIII)

diisodecyl PE diphosphite of formula (XIV) and



(XIV)

mono p-cumyl phenol diisodecyl phosphite of formula (XV)



(XV)

62. An essentially toxic-metal free liquid additive composition for use as at least a partial replacement of toxic metal stabilizer additive compositions for use in vinyl-containing resins, wherein the essentially toxic-free composition consists essentially of:

(a) at least one phosphite ester selected from the group consisting of aryl phosphites, alkyl phosphites, aryl/alkyl phosphites, bisphenol-A phosphites,

dialkylene glycol phosphites and polydialkylene glycol phosphites, pentaerythritol phosphites, p-cumyl phenol phosphites and blends thereof; and

(b) an effective amount of zinc; and further wherein a molar ratio of P/Zn is from approximately 0.05 to 0.4% zinc to approximately 4 to 10% phosphorus.

a1
cont.

63. The composition of claim 62 wherein

(a) said zinc is from approximately 100 to 500 ppm; and

(b) said molar ratio of P/Zn is from approximately 0.1 to 0.3% zinc to approximately 5 to 8% phosphorus.

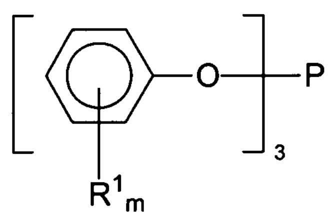
64. The composition of claim 63 wherein

(a) said zinc is from approximately 100 to 250 ppm; and

(b) said molar ratio of P/Zn is from approximately 0.15 to 0.25% zinc to approximately 6 to 7% phosphorus.

65. The composition of claim 62 wherein said at least one phosphite ester is selected from the group consisting of

aryl phosphites of formula (I)



(I)

wherein:

R^1 is independently selected from the group consisting of H, C_{1-18} alkyl, C_{1-18} alkoxy, halogens; and

m is an integral value from 0 to 5 inclusive,

alkyl phosphites of formula (II)

$$\left[R^2\text{—}O \right]_3\text{—}P$$

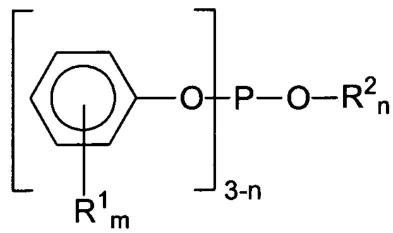
(II)

a1 cont.

wherein:

R^2 is selected from the group consisting of C_{1-18} alkyl,

alkyl/aryl phosphites of formula (III)



(III)

wherein:

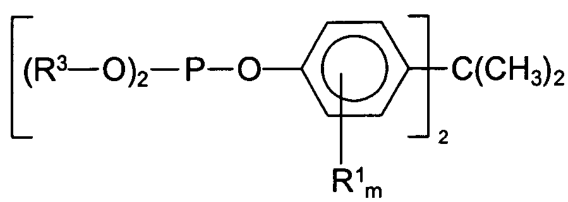
R^1 is as previously defined;

R^2 is as previously defined;

m is an integral value from 0 to 5 inclusive; and

n is an integral value from 1 to 2,

bisphenol-A phosphites of formula (IV)



(IV)

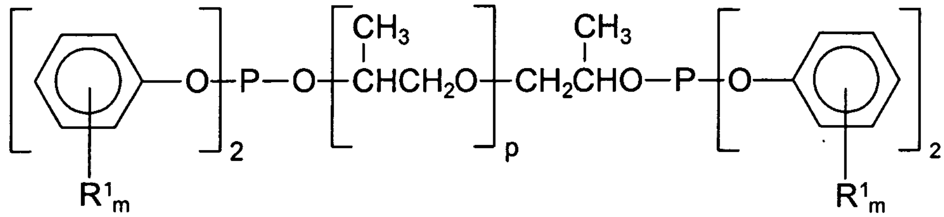
wherein

R^1 is as defined previously;

R^3 is C_{8-18} alkyl; and

m is an integral value from 0 to 5 inclusive,

polydialkylene glycol phosphites of formula (V)



(V)

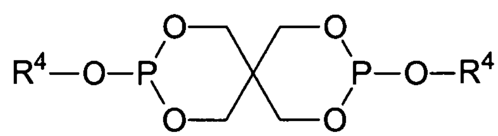
wherein:

R^1 is as defined previously;

m is an integral value from 0 to 5 inclusive; and

p is an integral value from 0 to 1 inclusive,

pentaerythritol phosphites of formula (VI)

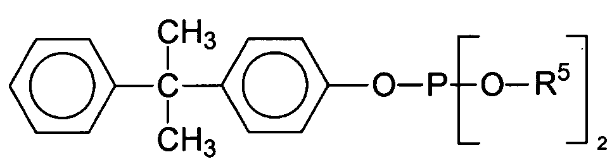


(VI)

wherein:

R^4 is selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy, and

p-cumyl phenol phosphites of formula (VII)



(VII)

al
cont.

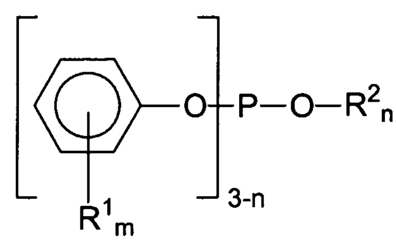
wherein:

R^5 is independently selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy.

66. The composition of claim 65 wherein
(a) a percentage weight loss of said composition as measured as a difference between a start and an end weight of said composition as measured after exposure to two hours at 110°C, is less than 1% by weight.

67. The composition of claim 66 wherein
(a) a percentage weight loss is less than 0.5% by weight.

68. The composition of claim 67 wherein said at least one phosphite ester is selected from the group consisting of
alkyl/aryl phosphites of formula (III)



(III)

wherein:

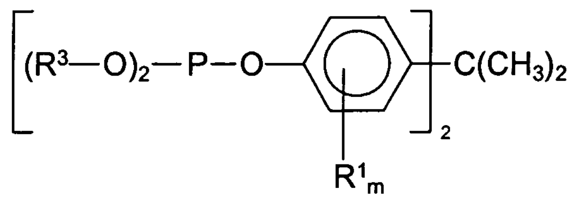
R^1 is independently selected from the group consisting of H, C_{1-18} alkyl, C_{1-18} alkoxy, halogens; and

R^2 is selected from the group consisting of C_{1-18} alkyl,

m is an integral value from 0 to 5 inclusive; and

n is an integral value from 1 to 2,

bisphenol-A phosphites of formula (IV)



(IV)

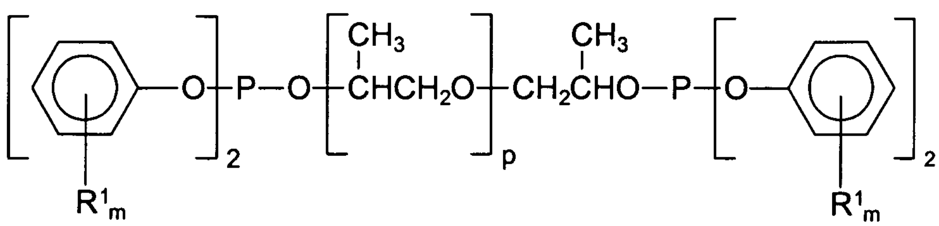
wherein

R^1 is as defined previously;

R^3 is C_{8-18} alkyl; and

m is an integral value from 0 to 5 inclusive,

polydialkylene glycol phosphites of formula (V)



(V)

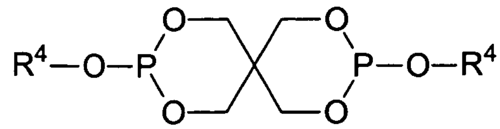
wherein:

R^1 is as defined previously;

m is an integral value from 0 to 5 inclusive; and

p is an integral value from 0 to 1 inclusive,

pentaerythritol phosphites of formula (VI)

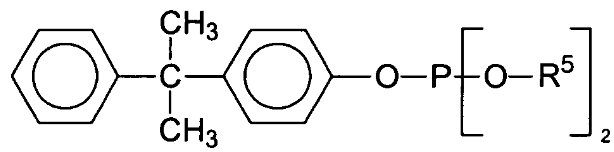


(VI)

wherein:

R^4 is selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy, and

p-cumyl phenol phosphite is of formula (VII)



(VII)

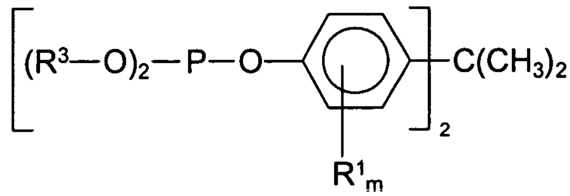
wherein:

R^5 is independently selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy.

69. The composition of claim 68 wherein said at least one phosphite ester is selected from the group consisting of

bisphenol-A phosphites of formula (IV)

a1 cont.



(IV)

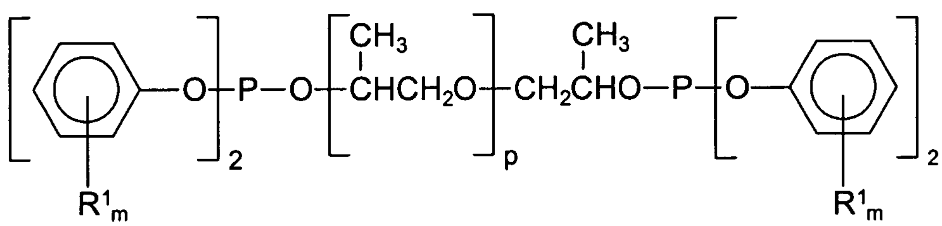
wherein

R^1 is independently selected from the group consisting of H, C_{1-18} alkyl, C_{1-18} alkoxy, halogens; and

R^3 is C_{8-18} alkyl; and

m is an integral value from 0 to 5 inclusive,

polydialkylene glycol phosphites of formula (V)



(V)

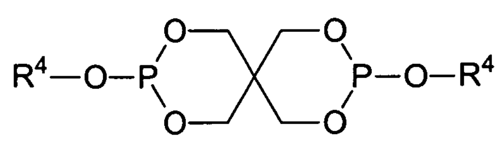
wherein:

R^1 is as defined previously;

m is an integral value from 0 to 5 inclusive; and

p is an integral value from 0 to 1 inclusive, and

pentaerythritol phosphites of formula (VI)



(VI)

wherein:

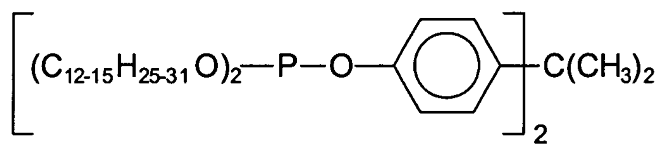
R^4 is selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy.

70. The composition of claim 69 wherein said composition is essentially free of barium, cadmium and calcium.

71. The composition of claim 70 wherein

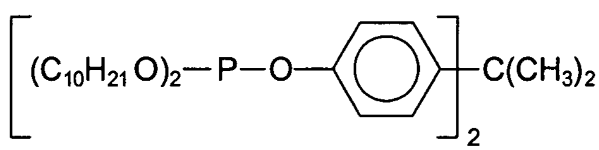
(a) said phosphite ester is selected from the group consisting of

C_{12-15} bisphenol-A phosphite of formula (VIII)



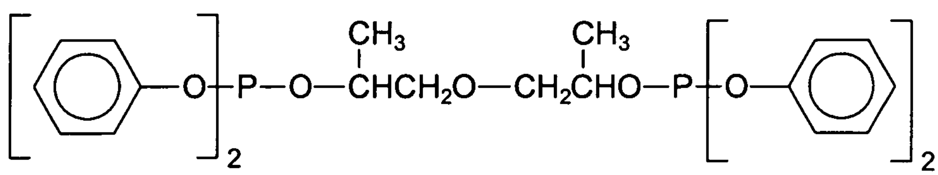
(VIII)

C_{10} bisphenol-A phosphite of formula (IX)



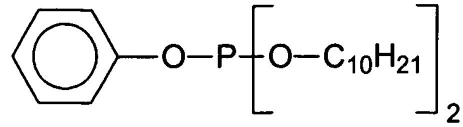
(IX)

tetraphenyl dipropylene glycol diphosphite of formula (X)



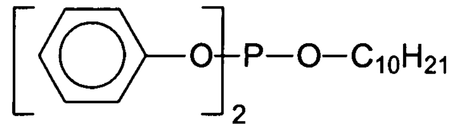
(X)

phenyl diisodecyl phosphite of formula (XI)



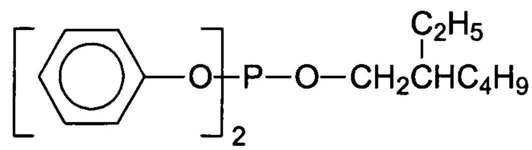
(XI)

diphenyl isodecyl phosphite of formula (XII)



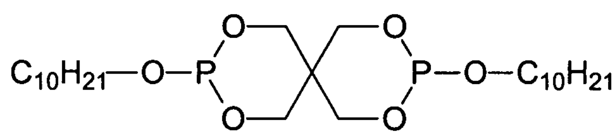
(XII)

diphenyl 2-ethylhexyl phosphite of formula (XIII)



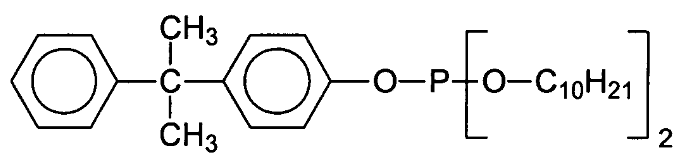
(XIII)

diisodecyl PE diphosphite of formula (XIV) and



(XIV)

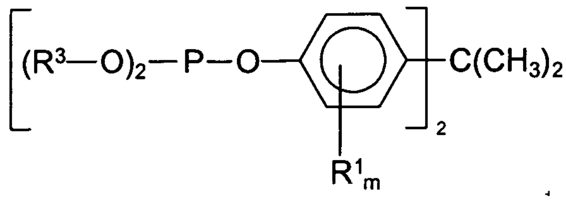
mono p-cumyl phenol diisodecyl phosphite of formula (XV)



(XV)

72. A additive composition for polyvinyl chloride resin which comprises:

(a) at least one phosphite ester selected from the group consisting of bisphenol-A phosphites of formula (IV)



(IV)

a1 cont.

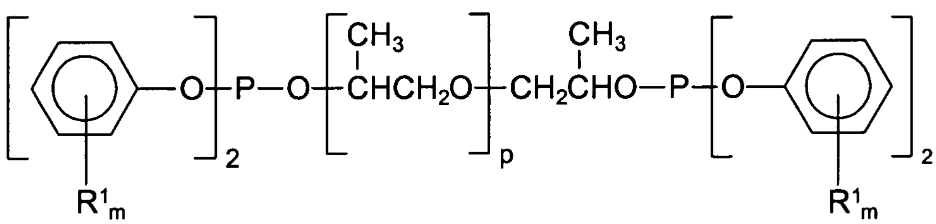
wherein

R^1 is independently selected from the group consisting of H, C_{1-18} alkyl, C_{1-18} alkoxy, halogens; and

R^3 is C_{8-18} alkyl; and

m is an integral value from 0 to 5 inclusive,

polydialkylene glycol phosphites of formula (V)



(V)

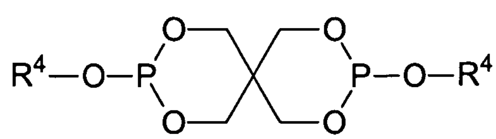
wherein:

R^1 is as defined previously;

m is an integral value from 0 to 5 inclusive; and

p is an integral value from 0 to 1 inclusive,

pentaerythritol phosphites of formula (VI)



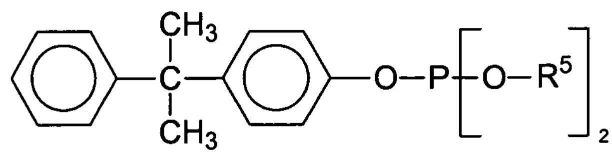
(VI)

a1
cont.

wherein:

R^4 is selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy, and

p-cumyl phenol phosphite is of formula (VII)



(VII)

wherein:

R^5 is independently selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy; and

(b) approximately 50 to 800 ppm zinc per 100 parts resin.

73. The composition of claim 72 wherein
   (a) said phosphite esters range from approximately about 1 to 8 phr inclusive; and
   (b) said zinc ranges from approximately about 50 to 800 ppm and further wherein said zinc is from a zinc carboxylate.

74. The composition of claim 73 wherein
   (a) said phosphite esters range from approximately about 2 to 4 phr inclusive; and

(b) said zinc carboxylate ranges from approximately about 100 to 500 ppm and further wherein said zinc carboxylate is selected from the group consisting of zinc octoate, zinc 2-ethylhexoate, zinc hexoate, zinc neodecoate, zinc decoate, zinc dodecanoate, zinc isostearate, zinc oleate, zinc stearate, zinc tallow fatty acids, zinc palmitate, zinc myristate, zinc laurate, and zinc benzoate.

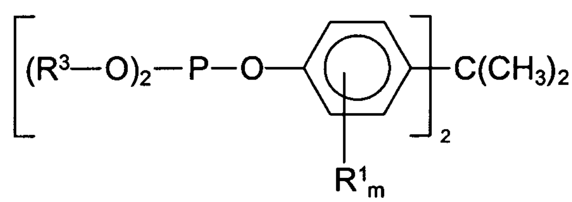
75. The composition of claim 74 wherein

(a) said phosphite esters range from approximately about 2 to 4 phr inclusive; and

(b) said zinc carboxylate ranges from approximately about 100 to 250 ppm.

76. The composition of claim 75 wherein

(a) said phosphite is selected from the group consisting of bisphenol-A phosphites of formula (IV)



(IV)

wherein

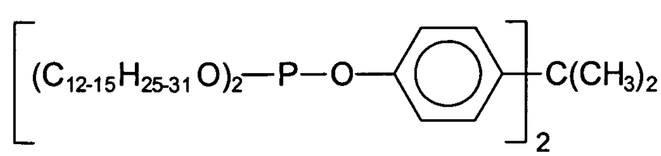
R^1 is independently selected from the group consisting of H, $C_{1\text{-}18}$ alkyl, $C_{1\text{-}18}$ alkoxy, halogens; and

R^3 is $C_{8\text{-}18}$ alkyl; and

m is an integral value from 0 to 5 inclusive,

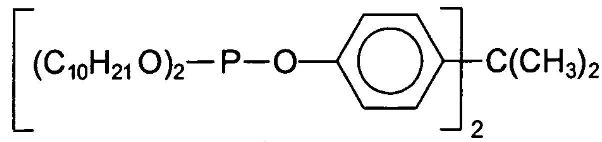
77. The composition of claim 76 wherein

(a) said phosphite ester is selected from the group consisting of $C_{12\text{-}15}$ bisphenol-A phosphite of formula (VIII) and



(VIII)

C_{10} bisphenol-A phosphite of formula (IX)

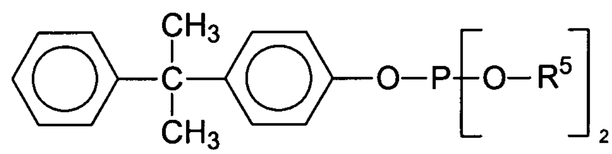


(IX).

78. The composition of claim 72 wherein

(a) said phosphite ester is

p-cumyl phenol phosphite is of formula (VII)



(VII)

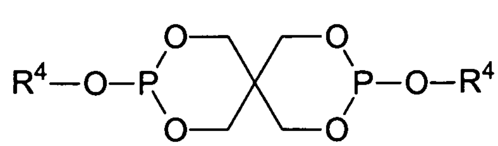
wherein:

R^5 is independently selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy.

79. The composition of claim 72 wherein

(a) said phosphite is selected from the group consisting of

pentaerythritol phosphite of formula (VI)

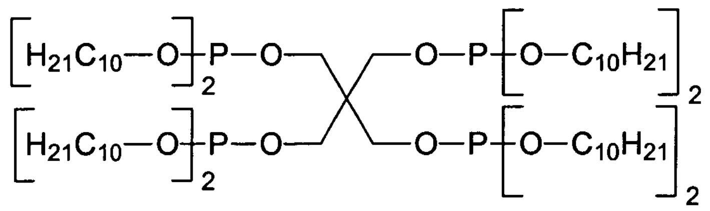


(VI)

wherein:

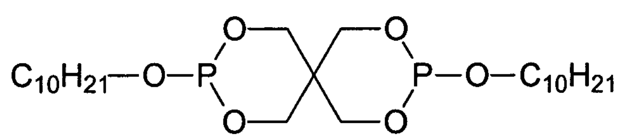
R^4 is selected from the group consisting of C_{8-18} alkyl; C_{6-30} aryl, C_{6-30} fused aryl rings, C_{7-35} alklaryl, C_{7-35} arylalkyl, and substituted derivatives thereof, wherein the substituents are selected from the group consisting of halogens, hydroxyl, C_{1-4} alkyl, and C_{1-4} alkoxy, and

PE phosphite of the following formula



80. The composition of claim 79 wherein

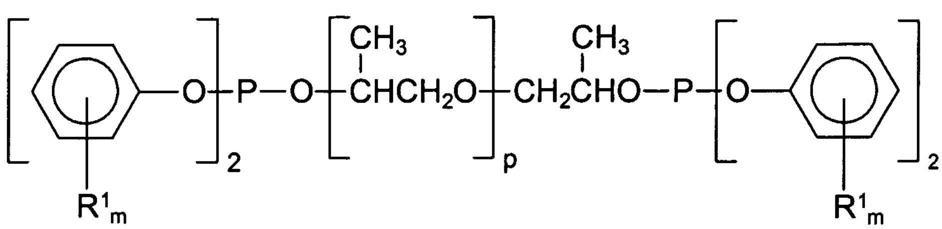
(a) said phosphite is



81. The composition of claim 72 wherein

(a) said phosphite ester is a

polydialkylene glycol phosphite of formula (V)



(V)

wherein:

R^1 is independently selected from the group consisting of H, C_{1-18} alkyl, C_{1-18} alkoxy, halogens;

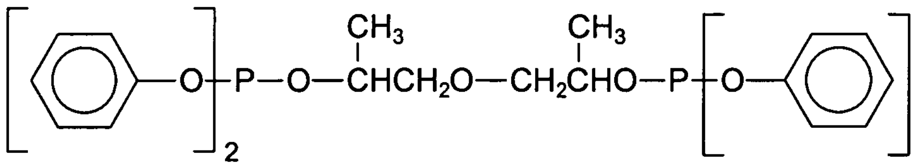
m is an integral value from 0 to 5 inclusive; and

p is an integral value from 0 to 1 inclusive.

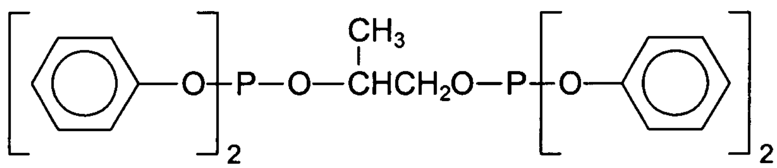
a1 cont.

82. The composition of claim 81 wherein

(a) said polydialkylene glycol phosphite is selected from the group consisting of



and



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Claim to Priority

The examiner has noted that an incorrect claim to priority under 35 U.S.C. §119(e) was made. As suggested by the examiner, a petition has been filed with the Petitions Office in conjunction with a corrected declaration which identifies the correct filing date of the provisional application, an inadvertent mistake. In reviewing the file, it is apparent that reliance was placed on the handwritten return card received from the office of another law firm in identifying the filing date. When the complete file was provided by the other law firm, it was noted that there was an inconsistency between the handwritten date and the date identified by the Patent Office on the filing receipt.

Upon the granting of the Petition, it is respectfully submitted that this inadvertent error is corrected and the claim to priority will be allowed. A copy of the Petition is attached to this amendment response for the benefit of the examiner.

Should the Petitions Office grant the above submitted Petition, the applicant's attorney respectfully requests that the following amendment be made to page 1 of the specification. After the title, and before the Technical Field of the Invention, please insert

-- This application claims priority from United States provisional patent application serial number 60/273,303 filed March 2, 2001, United States provisional patent application serial number 60/314,181 filed March 16, 2001, and United States provisional patent application serial number 60/315,746 filed August 29, 2001. --

A replacement page has been provided.

Status

The application presently contains the following claims:

Independent Claim #	*Dependent Claim #s*
42	43-51
52	53-61
62	63-71
72	73-82

Claims 1-41 are deleted in this amendment while claims 42-82 are newly submitted. Support for the newly submitted claims may be found in the originally submitted claims. The applicant's attorney thanks the examiner for his thorough examination and the observations contained within the office action. The inventors and their attorney respectfully disagree with many of the conclusions drawn by the examiner with regard to the *Prior Art*, and through the thorough response presented, solicit the examiner to revisit his initial conclusions regarding the patentability of this invention.

U.S.C. §112, Second paragraph and Responsive Arguments

The examiner has rejected claims 1-41 under this section as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The examiner has pointed out to the use of the term "resin" is the issue when the disclosure was represented to teach that the invention was substantially free of any resin.

The applicants' attorney is completely puzzled by this rejection in that the additive was always for use in a resin, the improvement coming from the partial or total elimination of heavy-metals which typically are included in a resin additive package, particularly for PVC. However, the examiner does bring up a good point and the independent claims have been rewritten to recite that the polymer additive is intended for use in a resin. The amount of zinc added has also been corrected. Support for this correction may be found in paragraph [0026].

The examiner has additionally rejected claims 32-34 which recite amounts of a component (a) in terms of "phr" which normally refers to a dosage in a resin, which the examiner has represented to contradict his understanding of the invention which was to be substantially free of resin. Once again, the applicant's attorney regrets that any confusion may have been caused by the phraseology in the claims. The phosphite ester is added into a resin at the phr level whereas catalytic amounts of zinc are added, typically at the ppm level. The inconsistency noted has been corrected in the identified claims.

The examiner has also rejected claims 1-41 under this paragraph in that the phraseology regarding the amount of zinc rendered the claims unclear. As identified in the previous paragraph, this issue has been addressed in other independent claims in addition to the claims identified previously.

The examiner has rejected claims 33-36 and identified an extraneous comma present between "zinc" and "decoate" in claim 33 rendering the claim unclear as well as those depending from it. This careful reading of the claims is appreciated and the comma has been removed, thereby addressing and overcoming the issue raised.

U.S.C. §112, First paragraph and Responsive Arguments

The examiner has rejected claims 1-31 and 37-41 under this section, in that the specification was represented to only provide support for zinc compounds and not zinc metal. As stated in the patent application as filed, for example, in published application, paragraph [0032], the specification talks about the addition of an "effective amount of an active zinc compound sufficient to ensure that the overall zinc level in the vinyl compounds (based on 100 parts per hundred parts resin, i.e., phr) falls within a range of about 50 to about 800 ppm, more preferably…" As clearly shown in the paragraph, the key is the level of zinc in the vinyl compound, not the amount of zinc compound.

Still further support can be found in paragraph [0026] wherein it is stated that the level of zinc is stated to be based by "maintaining or adjusting the overall zinc level in the vinyl compound to achieve or maintain a level of zinc of 50 to 800 ppm resin, preferably …" Once again, the key is the level of zinc in the vinyl compound, not the amount of zinc compound.

Additionally, in various locations, the term "carboxylate" was substituted for the term "compound" when the zinc was so further limited. Support for this amendment can be found in the published application, paragraph [0032] as originally filed.

Claim Objections and Responsive Arguments

The examiner has objected to claim 39 as being of improper dependent form for failing to limit the subject matter of a previous claim. The examiner has correctly noted the issue and claim 38 has now been rewritten into Markush form whereas claim 39 has been limited to a single species.

The examiner has objected to claim 41 as being of improper dependency due to an incorrect structure at page 8, #10. The correct structure has now been incorporated into the specification thereby addressing the objection to claim 41. A replacement page has been provided.

The examiner additionally noted that the structure noted in claim 41 would only be unique when p=0. The examiner's observation was once again, correct, and the appropriate modification to claim 41 has been made, thereby removing the objection to this claim.

Objections to the Specification and Responsive Arguments

The examiner has objected to the specification regarding the inconsistent use of phr, and has noted page 9, lines 9-10. This confusing terminology has been removed and a replacement page is submitted herewith.

The examiner has also noted this inconsistency in Table IX. This objection is believed to have been overcome by correctly identifying the quantity of resin as 100, rather than 98. A replacement page has been provided.

35 U.S.C. §102 Rejection & Responsive Arguments

The examiner has rejected claims 1-10 under this section, subparagraph (b) as being anticipated by Valdiserri (US 4,614,756 hereinafter '756). The examiner noted that the claims use the term "comprising" and therefore, do not exclude the tin additive of '756. The applicant's attorney would respectfully request the examiner revisit his conclusion in light of the following arguments.

Valdiserri '756

Valdiserri '756 teaches the use of zinc at a level of 0.125 to 0.25 phr (or equivalently 1250 to 2500 ppm). See Tables 1-2 and Examples #19-20. By contrast, the *Stevenson et al.,* invention uses zinc in the resin at a level of 50-800 ppm. This is more than an order of magnitude greater than the minimum amount of Zn in the resin required by *Stevenson et al.,* and more than 3 times the maximum. This is simply not a §102 reference as applied to the claims as currently pending in the application. Additionally, it must be noted that the goal of *Valdiserri* was to reduce the amount of organo tin mercaptide used. There is no teaching in the '756 patent of how it can be eliminated. In fact, the patent teaches that it is required.

It is important to place this technology into context. Tin stabilizers can be divided into two main groups, the first containing stabilizers with tin-oxygen bonds and the second stabilizers with tin-sulfur bonds. In the first group are tin carboxylates, which provide an excellent light and weathering stability to PVC products and find rising use

particularly in outdoor applications. Some examples are transparent panels and translucent double-wall panels for greenhouses. Specific stabilizers within this group include octyltinmaleates, which are approved for the production of blow molding films, like candy wrapping.

The second group is often described as tin mercaptides. These stabilizers are highly efficient and allow the production of crystal clear, rigid vinyl articles even under high-demanding processing conditions. ***Tin mercaptides have a typical characteristic odor, which might be nuisance during processing.*** They show moderate light-stability. The most powerful compounds within the mercaptide class are the mercapto-acetate (thioglycolate) ester derivates and these are the most common tin compounds applied today. The tin mercaptides are usually mixtures of di-alkyl and mono-alkyl tin-compounds, of which the ratio can be varied to create stabilizers with best performance, mainly dependent upon the used PVC-type and the end-use application.

It is only the *Stevenson et al.,* invention that shows how organo tin mercaptide can be eliminated with the attendant benefit of removing any maliferous odor typically associated with mercaptides.

35 U.S.C. §103 Rejection & Responsive Arguments

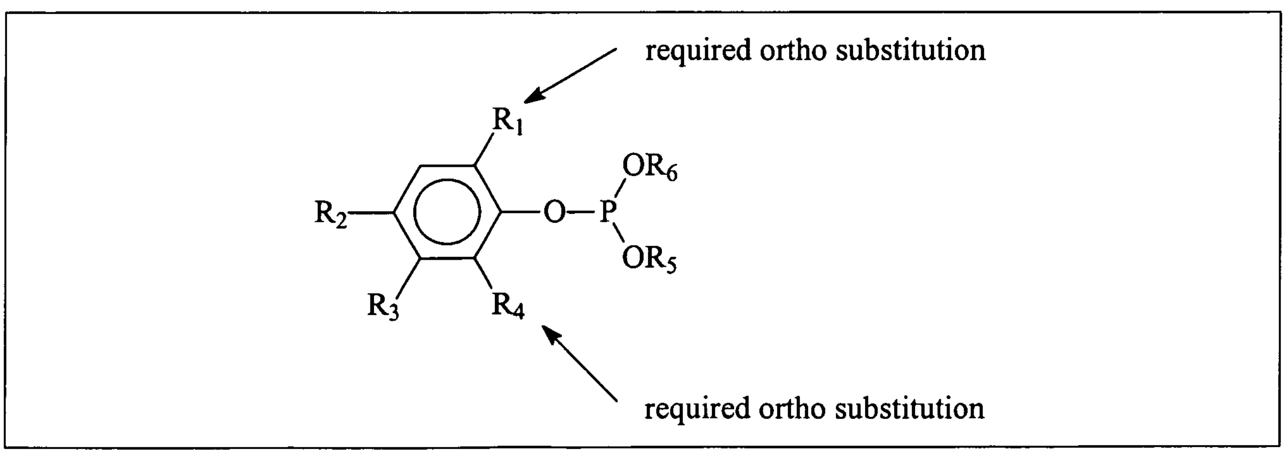
Minagawa et al., '756

The examiner has rejected claims 1-7 and 9-13 under this section, subparagraph (a) over *Minagawa* et al., US 4,282,141 ('141).

The examiner has identified col 10, lines 55-65 as pertinent wherein the amount of metal salt used was identified as ranging from 0.01 to 10 per 100 parts resin. While this is correct, it is equally important to note that the patent requires the use of a 1,3-diketone compound in conjunction with the metal salt. The essence of the invention involves the formation of zinc coordination complexes with the diketone, a facet which is not present in the *Stevenson et al.,* invention.

This is significant in that an emerging goal in the stabilizer industry is to develop nonfugitive liquid stabilizers that are nonfugitive both during and subsequent to the processing of PVC compounds and fabricated products. Many commercial liquid mixed metal heat stabilizers, because of their complex compositions and inherent reactivity, give rise to undesirable fugitive emissions during and subsequent to the processing of PVC compositions in which they are contained. These fugitive emissions manifest themselves as odors, vapors, and reportable VOC's in the work area. They often concurrently result in the deposition of incompatible, sticky deposits (plate out) on processing equipment. In their worst form, fugitive species continue to be emitted slowly from fabricated vinyl films and articles giving rise to downstream odors, monomolecular films and tacky exudates which interfere with printing operations and generally detract from the aesthetic qualities of the PVC article. The volatility characteristics are inherent based on the choice of any combination of materials. However, it is the express choice of *Stevenson et al.,* to exclude volatiles which is a distinguishing feature of the invention.

The *Minigawa* '141 patent additionally requires double ortho substitution in the phosphites, as clearly shown in the following organic phosphite formula with required ortho substitution. It is the combination of required ortho substitution plus the incorporation of a diketone which leads to the results of *Minigawa*, elements which are not present in *Stevenson et al.* As taught in *Minigawa*, it is the tautomerism of the enol / keto configuration of the diketone which leads to the beneficial result. See col 6, lines 30 through 68.



Housel '514

The examiner has rejected claims 1-8, 10-18, 20, 31-32 and 38 under this section, subparagraph (a) as unpatentable over *Housel*, US 4,340,514 ('514). The examiner has represented that *Housel* teaches "non-toxic" liquid stabilizers for halogenated hydrocarbon resins in which zinc is in the form of a carboxylate, and which is compounded with the resin at 0.25 to 4% of the resin which was represented to overlap the claimed levels of zinc. The volatility was represented to be inherent. The examiner did admit that the reference did not disclose mixtures "essentially free" of calcium.

The applicant would respectfully request the examiner to revisit his initial conclusion regarding the amount of zinc which is added to the resin. The 0.25% zinc is equivalent to 2500 phr, a level which is significantly in excess of the 800 ppm levels claimed in the patent.

Additionally, the applicant would respectfully request the examiner to revisit his conclusion regarding the "non-toxic" labeling of the zinc as well as the form of the

Toxicity Information for Zinc resinate Top

Note: Information for many chemicals is incomplete and may not be fully representative of effects on humans. Why?

Summary Toxicity Information

PAN Bad Actor Chemical [1]	Acute Toxicity	Carcinogen	Cholinesterase Inhibitor	Ground Water Contaminant	Developmental or Reproductive Toxin	Endocrine Disruptor
☠	?	Not Likely	No	?	☠	?

☠ Indicates high toxicity in the given toxicological category.

? Indicates no available weight-of-the-evidence summary assessment. For additional information on toxicity from scientific journals or registration documents, see the "Additional Resources for Toxicity" section of the chemical detail page.

1. PAN Bad Actors are chemicals that are one or more of the following: highly acutely toxic, cholinesterase inhibitor, known/probable carcinogen, known groundwater pollutant or known reproductive or developmental toxicant. NOTE! Because there are no authoritative lists of Endocrine Disrupting (ED) chemicals, EDs are not yet considered PAN Bad Actor chemicals.

product, which the examiner characterized as zinc carboxylate. This would appear to be misleading, in that the '514 patent seems to describe it as a zinc resinate. While the patent does indicate that it is the reaction product of a zinc compound with a naturally occurring terpene hydrocarbon mono-carboxylic acid, this product is far from benign as illustrated in the Pesticides Action Network web site, a portion of which is reproduced above, wherein it was indicated to be in a class of "chemicals that are one or more of the following: highly acutely toxic, cholinesterase inhibitor, known/probable carcinogen,

known groundwater pollutant or known reproductive or developmental toxicant."

Once again, as indicted by the examiner, the reference does not teach how to remove the toxicity of the additive, and perhaps in 1982, the publication date of the patent, this risk was unknown.

Rhodes et al., '200 in view of Nosu et al., '783 and Kotani '030

The examiner has rejected claims 1-41 under this section, subparagraph (a) as unpatentable over Rhodes et al., (US 3,755,200 or '200) in view of Nosu et al., (US 5,120,783 or '783) and Kotani et al., (US 5,414,030 or '030). The examiner has represented that *Rhodes* teaches liquid stabilizer compositions for PVC comprising phosphite esters and metal carboxylates, including zinc. *Kotani* was represented to show various phosphites within the ordinary skill in the art while *Nosu* was indicated to be relied upon for its teaching that cadmium and barium are undesirable an that zinc and calcium are preferred for their low cost and low toxicity.

The applicant's would respectfully request the examiner to revisit his initial conclusions regarding the patentability of the *Stevenson et al.,* invention in light of the following arguments. First, it is correct that zinc stearate is represented in the Rhodes '200 patent to provide excellent results, however, the patent provides no guidance as to how to remove the additional required components, namely a partial ester of a polyglycerol and an epoxy plasticizer, which are required for this system to be capable of forming a homogeneous solution which does not undergo phase separation when allowed to stand at ambient conditions for prolonged periods of time. Additionally, the '200 patent expressly teaches a specialized process by which the composition must be formed, namely "through the utilization of a specific blending technique which consists of first forming a solution of the metal salt, the epoxy compound and the organo-phosphorous, followed by heating ... The polyglycerol partial ester is then added to the resulting uniform solution and blended therewith." (See col 2, lines 11-24). The *Stevenson et al.,* invention does not require any epoxy compound.

Second, the majority of liquid stabilizer systems are liquid mixed metal soaps

which have similarities to some Ca-Zn stabilizers and are generally in the form of a carboxylate. As in the case of Ca-Zn heat stabilizers, all of these products require the addition of co-stabilizers to provide optimum performance. These are the same type of products as are used with Ca-Zn stabilizers and solvents are sometimes incorporated.

And third, *Rhodes* uses trialkyl phosphites, particularly tris(nonylphenyl) phosphite, (TNPP) which are not particularly suitable for use in the *Stevenson et al.,* invention. The *Rhodes* patent teaches a process in which the key is to heat the zinc stearate into the TNPP. This thrust of this patent is the preparation of improved antistatic and antifogging properties. There is no link that the applicant is aware of that improving these properties have any relationship to improving the heat or light stability of a halogenated resin.

In order to supplement the deficiencies in the teachings of *Rhodes*, the teachings of *Kotani* were combined, which the examiner has represented to stand for the proposition that various phosphites are useful in the invention. However, this is a misapplication of *Kotani* because as clearly evidenced in the '030 patent, the *Kotani* invention is for a (a) a polyolefin resin; (b) a dripping agent; (c) a heat stabilizer; (d) a weather resistance improving agent; and (e) a solution of a hypophosphite compound in an organic solvent. It is certainly not clear why one looking to supplement the teachings of *Rhodes*, would selectively chose to focus on the phosphite heat stabilizers of *Kotani*, particularly when *Rhodes* focuses on polyvinyl resins and *Kotani* focuses on polyolefin resins, two types of resins which are not even in the same class of polymers.

Finally, in order to supplement the deficiencies of the above two references, the examiner has combined the teachings of *Nosu*. However, it is important to note in this patent that once again, in a manner similar to that of *Rhodes*, there are four required elements: namely (a) hydrotalcite; (b) zinc compound; (c) magnesium hydroxide; and (d) a beta-diketone and/or a phosphite compound. It is not clear why a researcher seeking to supplement the deficiencies of *Rhodes* and/or *Kotani* would selectively seek out the teaching that zinc salts are preferred. It would appear to be a fairly selective reading of *Nosu*. Additionally, *Nosu* requires a diketone as part of the additive package, and as was discussed earlier with respect to *Minigawa*, diketones represent fugitive emission

problems, which the *Stevenson et al.,* invention have overcome.

Request for Reconsideration

Applicant believes that independent claims 42, 52, 62 and 72 clearly define over the prior art and that the distinctions between the present invention and the prior art would not have been obvious to one of ordinary skill in the art. Additionally, claims 43-51 depend from and contain all of the limitations of independent claim 42; claims 53-61 depend from and contain all of the limitations of independent claim 52; claims 63-71 depend from and contain all of the limitations of independent claim 62; and claims 73-82 depend from and contain all of the limitations of independent claim 72; and therefore, by the limitations contained in the base independent claims, are felt to be patentable over the prior art by virtue of their dependency from independent claims which distinguish over the prior art of record. All pending claims are thought to be allowable and reconsideration by the Examiner is respectfully requested.

It is respectfully submitted that no new additional searching will be required by the examiner.

Additionally, the applicant's attorney is providing a Technical Bulletin dated April 2003 prepared by the client regarding this new technology, which may place the invention into perspective.

Fee Determination Record

A fee determination sheet is attached for this amendment response. The Commissioner is hereby authorized to charge any additional fee required to effect the filing of this document to Account No. 50-0983.

Conclusion

It is respectfully submitted that all references identified by the examiner have been distinguished in a non-obvious way. If the examiner believes that a telephonic conversation would facilitate a resolution of any and/or all of the outstanding issues pending in this application, then such a call is cordially invited at the convenience of the examiner.

Respectfully Submitted,
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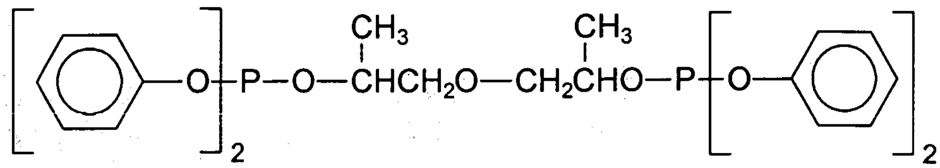
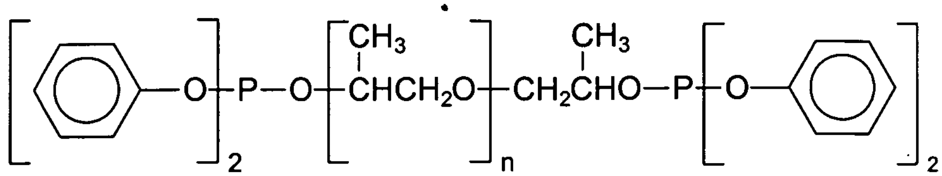
Dipropylene Glycol Phosphites or DPG Phosphites

#9 Tetraphenyl DPG diphosphite (DOVERPHOS® 11)



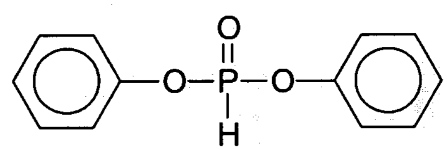
#10 Poly DPG phenyl phosphite (DOVERPHOS® 12)



Dialkyl/Aryl Hydrogen Phosphites

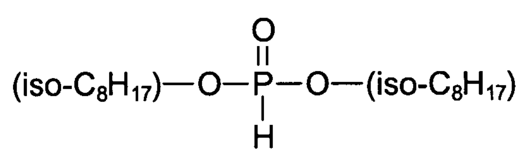
#11 Diphenyl phosphite

(DOVERPHOS® 213)



#12 Diisooctyl phosphite

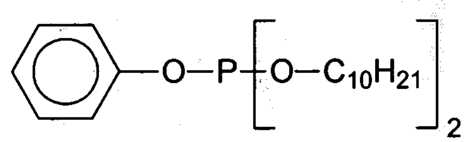
(DOVERPHOS® 298)



Alkyl/Aryl Phosphites

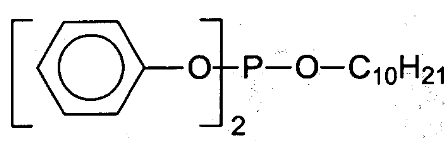
#13 Phenyl diisodecyl phosphite

(DOVERPHOS® 7)



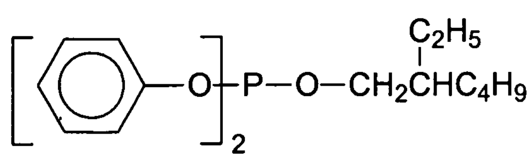
#14 Diphenyl isodecyl phosphite

(DOVERPHOS® 8)



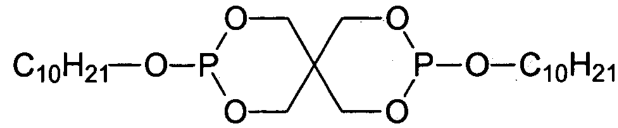
#15 Diphenyl 2-ethylhexyl phosphite

(DOVERPHOS® 9EH)

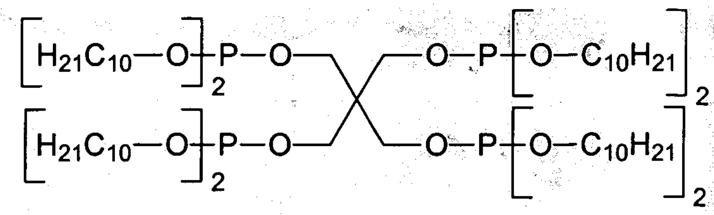


Pentaerythritol Phosphites or PE Phosphites

#16 Diisodecyl PE diphosphite (DOVERPHOS® 1220)

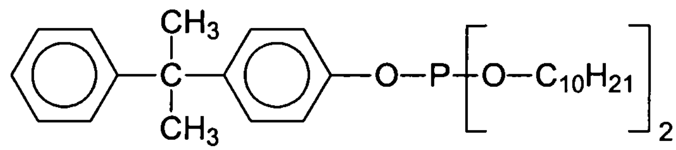


#17 (DOVERPHOS® 9708)

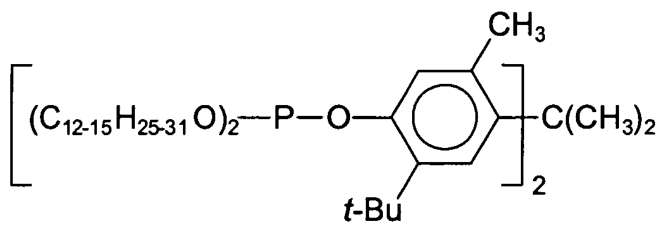


p-Cumyl Phenol Phosphites or PCP Phosphites

#18 Mono PCP diisodecyl phosphite



#19 (DOVERPHOS® 479)



The phosphite ester-based compositions of the present invention, used in flexible polyvinyl chloride compounds may partially or completely replace mixed metal PVC heat stabilizers containing toxic metals such as barium or cadmium without significantly detracting from the processability or initial color retention of the PVC compounds.

The phosphite ester-based compositions may consist of one or more phosphite esters and either contain or are used in conjunction with a small, but effective amount of an active zinc compound sufficient to ensure that the overall zinc level in the vinyl compounds falls within a range of about 50 to about 800 ppm, more preferably 100 to about 500 ppm based upon the PVC resin. The active zinc compounds may be selected zinc salts, particularly zinc carboxylates, which would preferably include these soluble chemical moieties: zinc octoate, zinc 2-ethylhexoate, zinc hexoate, zinc neodecoate, zinc, decoate, zinc dodecanoate, zinc isostearate, zinc oleate; as well as these insoluble chemical moieties: zinc stearate, zinc

Table VIII

	Color (Yellowness Index) Value			Color (Yellowness Index) Value	
	Prior Art U	A (120ppm)		Prior Art U	A (120ppm)
Time (min)	Dynamic Thermal Stability		Time (min)	Static Thermal Stability	
0	15	7	0	5.2	3.1
3	26	14	10	8.3	5.0
6	45	30	20	12.7	6.4
9	62	51	30	18.5	13.2
12	96	78	40	30.1	18.1
15	Char	char	50	39.4	29.8
18			60	52.1	46.7
			70	Char	72.1
			80		Char

Example #4

While levels of Zn in the range of 100-500 ppm are believed to be preferred, depending on the level of performance desired by the end-user, higher levels of Zn, e.g., 480 ppm can be added to the system, but still achieve acceptable performance.

Table IX

Component	PHR
PVC Resin	100
Plasticizer	41
Epoxidized soybean oil	3
$CaCO_3$	40
Surfactant	3
ATH	5
Lubricants	0.25
Stabilizer	2

The Yellowness Index was measured for the Prior Art stabilizer additive package in contrast to a composition of the instant invention using the compositions of Table IX in a short term static heat stability test. As is clearly seen in the following Table X, the heat

Dover PhosBooster products offer a greener approach to stabilizing flexible PVC compounds. Dover's patent-pending complex phosphite esters improve performance, reduce processing costs and contain no heavy metals or solvents. Designed to be used as full replacements of conventional mixed metal stabilizers, PhosBoosters eliminate heavy metals and substantially reduce VOCs.

Mixed metal stabilizers, such as Ba/Cd or Ba/Zn systems, contain from 20 to 70 percent phosphite. But they use commodity-grade phosphites, so they need the heavy metals to meet performance requirements. Dover PhosBooster products contain high performance proprietary phosphites. These yield better products and reduce costs.

Manufacturers are striving to reduce heavy metals in products, particularly in flexible PVC applications such as medical tubing, refrigerator gaskets, flooring, wall coverings and swimming pool liners. Producers of automotive trim and roofing membrane benefit from reduced costs and improved performance.

Dover PhosBooster products offer these advantages:

Improved:
- heat stability
- early color
- clarity
- weatherability
- printability

Reduced:
- volatiles & odor
- plate out
- stabilization costs

Absence of:
- heavy metals
- solvents

HOW PHOSBOOSTERS PERFORM

PhosBoosters react with harmful by-products that are produced when flexible PVC compounds break down during processing. The degradation caused by these substances builds color bodies that result in yellowing or blackened material. PhosBoosters stabilize flexible PVC by:

- Decomposing Hydroperoxides

$$R-O-OH + P(OR_1)_3 \longrightarrow R-OH + \overset{\overset{O}{\|}}{P}(OR_1)_3$$

- Replacing Labile Chlorines

$$R-Cl + P(OR_1)_3 \longrightarrow R-\overset{\overset{O}{\|}}{P}(OR_1)_2 + R_1Cl$$

R – Cl = terminal or allylic

- Adding to Double Bonds

$$\sim\!\!\sim C = C \sim\!\!\sim + P(OR_1)_3 \longrightarrow \sim\!\!\sim \underset{\underset{(R_1O)_2P=O}{|}}{C} - \overset{\overset{R_1}{|}}{C} \sim\!\!\sim$$

- Reacting with HCl

$$HCl + P(OR_1)_3 \longrightarrow POH(OR_1)_2 + R_1Cl$$

- Complexing Metal Chlorides

$$MCl_2 + P(OR_1)_3 \longrightarrow Cl_2\,M\!: P(OR_1)_3$$

FLEXIBLE FILLED APPLICATIONS IMPROVED HEAT STABILITY

For filled flexible applications, Dover PhosBoosters improve the heat stability and broaden the processing window, allowing processors to run hotter and faster. Dover's 600 series product line is designed specifically for filled applications to offer excellent performance while maintaining cost efficiency. In this example, optimum performance is achieved using Dover PhosBooster 635 as the stabilizer product.

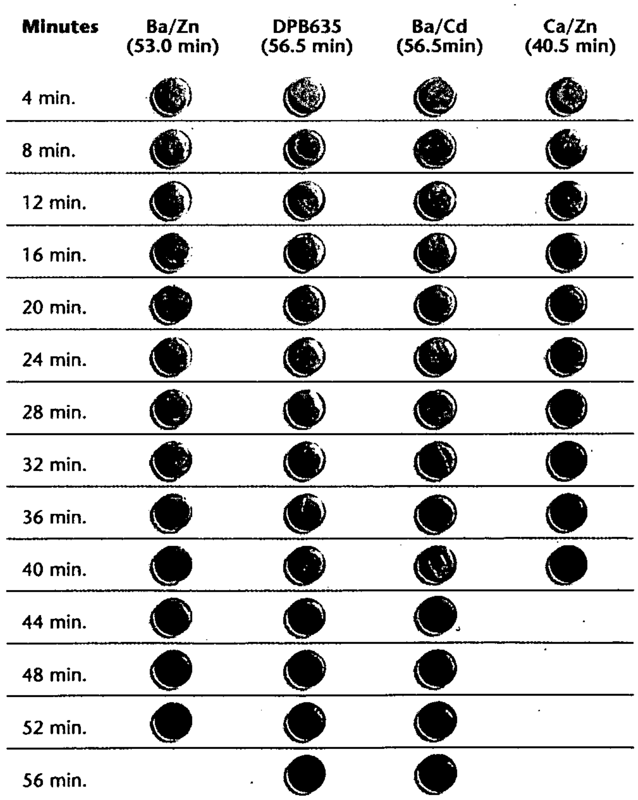


FIGURE 1
Brabender temperature: 190°C; RPM: 100; sample weight: 60g
Formulation: Stabilizer as indicated at 2 phr, 100 parts resin; 42 phr DOP; 25 phr calcium carbonate; 7 phr titanium dioxide; 3 phr ESO; 0.2 phr stearic acid

DOVER Chemical Corporation
A Subsidiary of ICC Industries Inc.

continued on inside...

continued from front...

PhosBooster 635 is a versatile stabilizer that offers excellent color stability throughout the entire processing window. In a moderately filled application, PhosBooster 635 gives improved performance versus a conventional Ba/Zn stabilizer (Figure 2) without the use of heavy metals and solvents. Additionally, 635 can significantly reduce emissions associated with the stabilizer.

Dover PhosBooster 680 is designed for highly filled applications as a replacement for typical mixed metal stabilizers. PhosBooster 680 offers superb early color performance while maintaining good processing stability. 680 shows exceptional performance versus a standard Ba/Cd product (Figure 3) in a highly filled application.

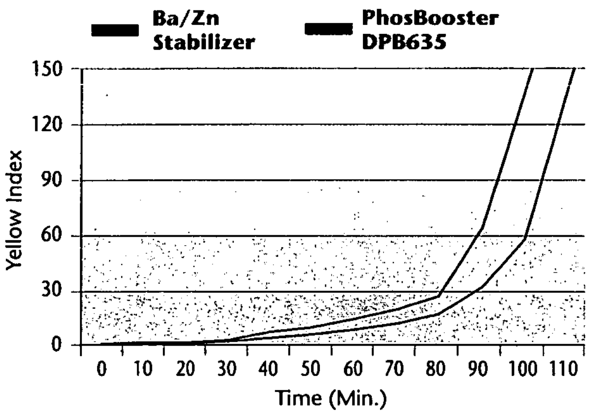


FIGURE 2
Masterbatch: 100 parts resin; 45 phr DOP; 30 phr calcium carbonate; 2.5 phr ESO; .15 stearic acid; 2 phr stabilizer

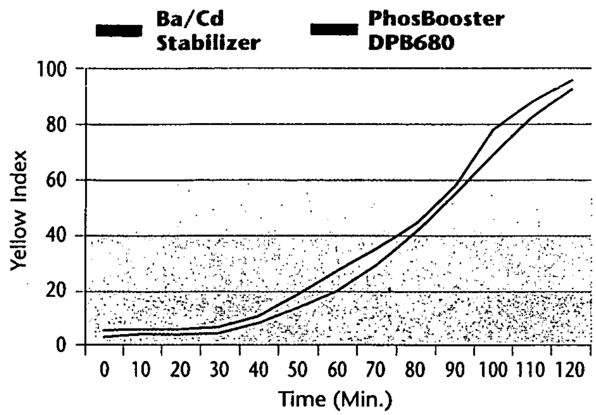


FIGURE 3
Masterbatch: 100 parts resin; 32 phr DINP; 20 phr secondary plasticizer, 45 phr calcium carbonate, 3 phr ESO, .2 stearic acid, 2.5 phr stabilizer

FLEXIBLE CLEAR APPLICATIONS PERFORMANCE AND CLARITY

For clear flexible applications, Dover PhosBoosters improve clarity and give excellent stability. Dover's 700 series product line is designed specifically for clear applications to offer good thermal performance while maintaining cost efficiency. In this example, optimum performance is achieved using Dover PhosBooster 770 as the stabilizer product.

Dover PhosBooster 770 is an efficient stabilizer for clear PVC applications, and offers exceptional processing stability and excellent weathering performance. PhosBooster 770 shows good performance versus a standard Ba/Zn product (Figure 5) in a clear application.

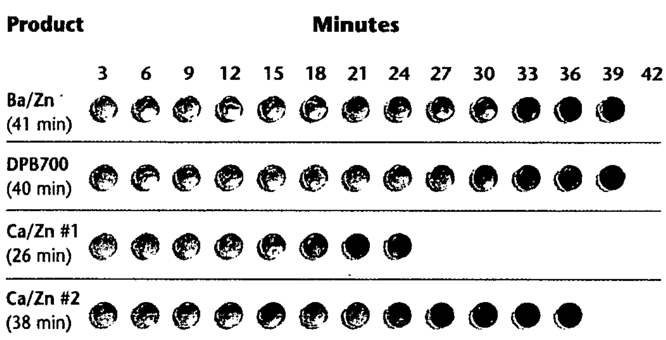


FIGURE 4
Brabender temperature: 175°C; RPM: 90; sample weight: 60g
Formulation: Stabilizer as indicated at 2 phr; 100 parts resin; 45 phr DOP; 2 phr ESO; 0.15 phr stearic acid

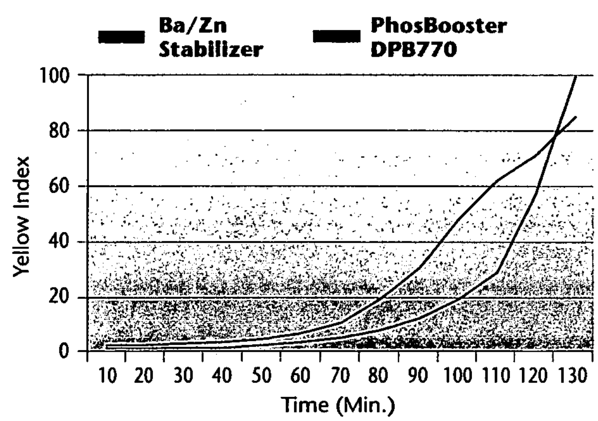


FIGURE 5
Masterbatch: 100 parts resin; 47 phr DIDP; 2.5 phr ESO; .1 phr stearic acid; 2.5 phr Stabilizer

Improved stability is only one aspect of how Dover PhosBoosters improve flexible PVC products. Dover's 700 series products improve clarity in clear applications where other stabilizers may produce haze.

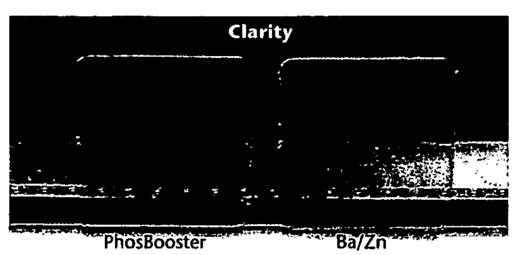


FIGURE 6

IMPROVED WEATHERABILITY

The improved color from Dover PhosBoosters' initial color and heat stability translates into improved weatherablity in both filled and clear applications.

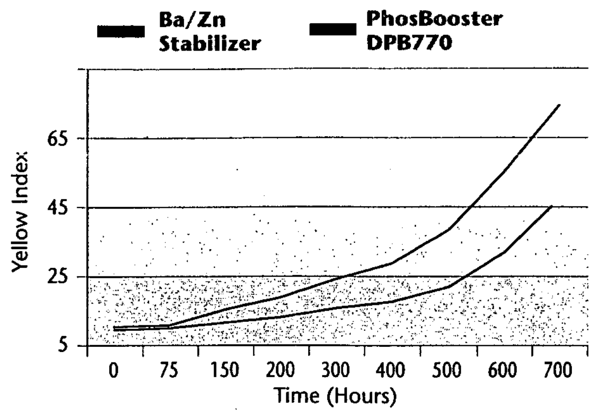


FIGURE 7
Masterbatch: 100 parts resin; 38 phr DOP; 2 phr ESO, .15 stearic acid, 2 phr stabilizer. Weathering: Xenon Arc, 65° C; 600 hrs; irradiance .35 W/m^2 @ nm

Figures 7 and 8 compare QUV weathering data for a Ba/Zn stabilizer and PhosBooster 770.

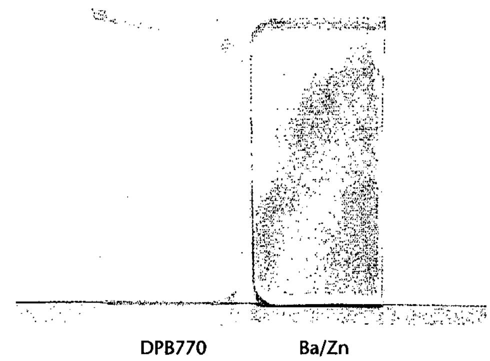


FIGURE 8
Clear PVC sample; 100 resin; 45 phr DOP; .1phr stearic acid; 2 phr stabilizer. Weathering: Xenon Arc, 65° C; 600 hrs; irradiance .35 W/m^2 @ nm

REDUCED VOLATILES AND EMISSIONS

By reducing or eliminating heavy metals and solvents from flexible PVC processing, Dover PhosBoosters cut pollution control costs. Volatiles are an increasing concern in the PVC industry. Compounders continuously look to reduce volatiles in the workplace or offer reduced emission products. Dover PhosBooster products contain no solvents, and offer far less volatility than traditional mixed metal stabilizers. This can be seen in Figure 9.

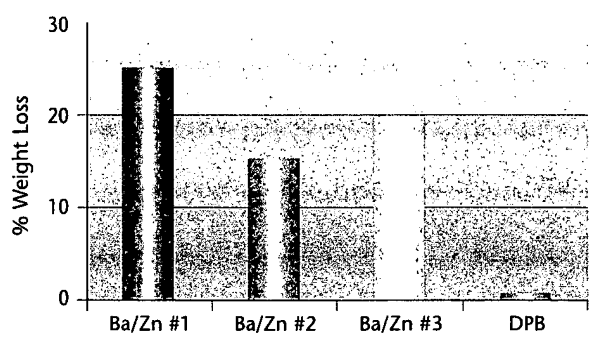


FIGURE 9
Percent weight loss in oven, 110° C, 2 hours

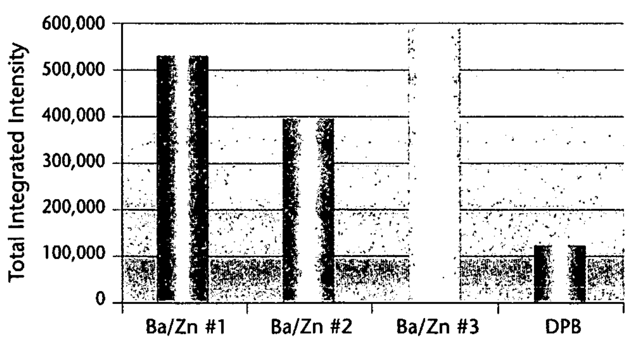


FIGURE 10
VOC emissions (GC-MS)

One way PVC compounders are now looking to meet the more environmentally friendly demands of consumers is to reduce emissions of their end products. PhosBoosters can significantly reduce emissions that are typically associated with mixed metal stabilizers. Figure 10 summarizes the relative VOC emissions of various Ba/Zn stabilizers compared to a PhosBooster product. Figures 11 and 12 present the GC-MS analysis of VOCs emitted from a flexible PVC compound stabilized with Ba/Zn #2 and the PhosBooster product. GC-MS analysis in Figure 11 shows the relative intensities of several VOCs' emission peaks associated with this commonly used stabilizer, while Figure 12 shows very limited emissions associated with the PhosBooster product.

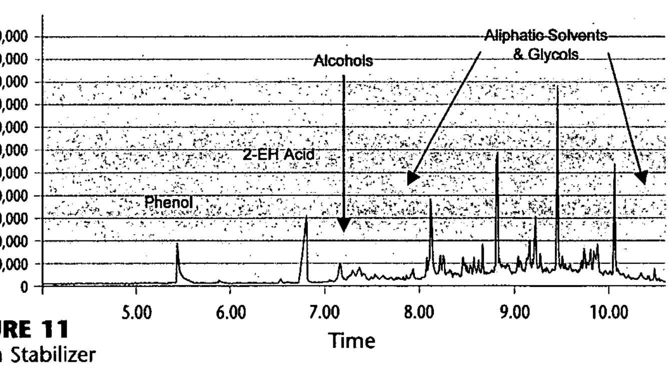


FIGURE 11
Ba/Zn Stabilizer

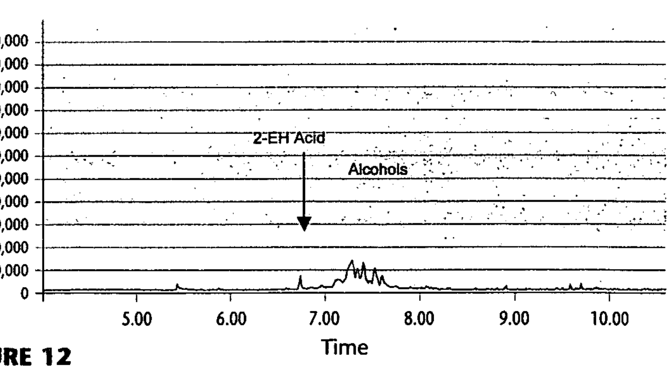


FIGURE 12
Dover PhosBooster

REDUCED PLATE OUT

PhosBoosters can also significantly reduce plate out issues associated with the stabilizer. This can reduce downtime associated with color changing clean outs. Plate out testing in Figure 13 shows dramatic reductions in plate out when compared to a problematic Ba/Zn stabilizer. In this test, a red flexible PVC compound was followed by a white flexible PVC compound. The results show that the Ba/Zn system had significant plate out, as picked up by the white clean-out compound, while the PhosBooster system sample had none.

FORMULATION:

100 parts resin	0.3 phr stearic acid
40 phr DOP	1 phr red dye
5 phr ESO	3 phr stabilizer

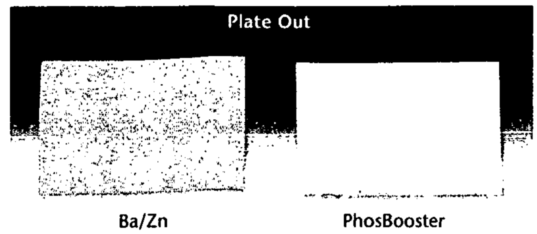


FIGURE 13

LONGER SHELF LIFE

Under normal storage conditions, Dover PhosBooster Advanced Phosphite Esters remain in homogenous solution. Mixed metal stabilizers can separate from solution after extended periods of time. Figure 14 shows a PhosBooster and a Ba/Zn mixed metal system after four months.

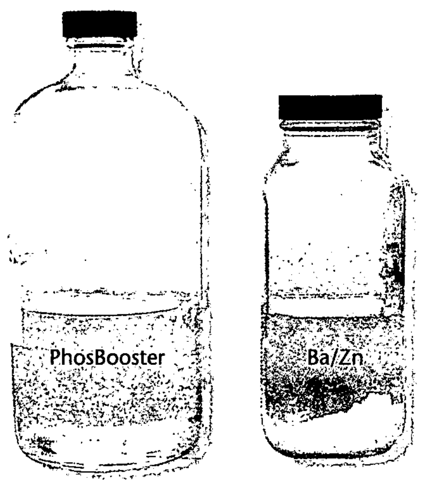


FIGURE 14

PRODUCTS TO MEET YOUR NEEDS

A full product line is available to meet specific processing requirements, including foaming agent kickers or applications requiring indirect food-contact approval. Your Dover representative will work with you to determine the best product and usage level to maximize the performance of your system.

DOVER PHOSBOOSTER PRODUCT LINE

- DPB600 – Filled PVC applications. Excellent color and long term stability
- DPB700 – Clear PVC applications. Excellent weathering and clarity
- DPB800 – Indirect food contact approved applications
- DPB900 – Foam agent kickers; Zinc based products

DOVER CHEMICAL CORPORATION

Dover Chemical Corporation is a subsidiary of New York-based ICC Industries Inc., a global leader in the manufacturing, marketing and trading of chemical, plastic and pharmaceutical products. Founded as an international trading enterprise, ICC now has manufacturing facilities in 23 locations in the United States, Europe, Israel, Russia, China and Turkey.

Dover, Ohio-based Dover Chemical Corporation is a leading producer of polymer additives, liquid and solid chlorinated paraffins, liquid and solid organophosphites, flame retardants and additives for water-based or oil-based coatings and metalworking fluids. The company sells its products in the U.S. and Canada from its headquarters location and to the rest of the world through ICC Industries Inc.

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